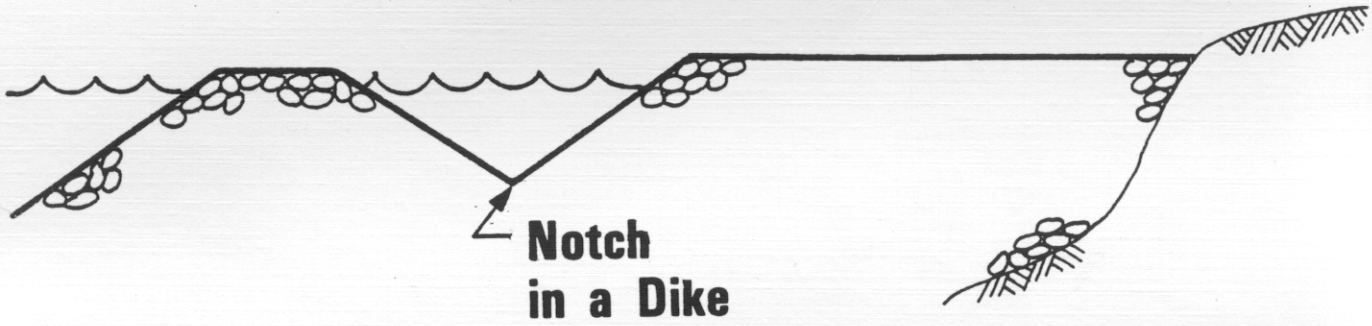
RIVERINE HABITAT AND FLOODWAY RESTORATION

MISSOURI RIVER
SIOUX CITY, IOWA TO THE MOUTH NEAR ST. LOUIS, MISSOURI

AN EVALUATION OF THE NOTCHED STRUCTURES IN CREATING ADDITIONAL BACKWATER AREAS



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EXECUTIVE SUMMARY

The Missouri River Bank Stabilization Navigation Project, from Sioux City, Iowa, to the Mouth, is a 735-mile open river system designed to provide a minimum 9 ft. x 300 ft. navigation channel. This was accomplished by aligning the river into a series of reversing bends and constricting the channel width. The concave bank of each bend was established by constructing revetment structures (parallel to flow), and the convex bank was developed by the construction of dike structures (perpendicular to flow). The dike systems were originally designed to promote the deposition of sediments between structures eventually converting shallow water into sandbar and terrestrial habitat.

In an effort to maintain or renew shallow water areas, the Omaha and Kansas City Districts of the Missouri River Division initiated a notching program during the 1975 navigation season. The purpose of the program was to provide a means for water to pass through and between the rock structures, thus preventing sediment deposition downstream and landward of the structures. During the period from 1975 through 1980, 1,306 notches were constructed by excavating a portion of existing stonefill structures or omitting repairs on small portions of damaged structures.

This study was undertaken to develop design criteria and determine the extent to which the notch program achieved the following goals:

a. Maintain the flow conveyance capability of the channel.

b. Maintain or increase the amount of shallow water habitat.

c. Have no adverse impact on the navigation channel and bank stabilization features of the project.

To accomplish this analysis, the river was divided into two reaches. The upstream reach, from Sioux City, Iowa, to Rulo, Nebraska, was evaluated by the Omaha District; and the downstream reach, from Rulo to the Mouth near St. Louis, Missouri, was evaluated by the Kansas City District. In addition, a cooperative agreement was entered into with the National Stream Alteration Team (NSAT) of the U.S. Fish and Wildlife Service to study the impact of the notches on the acquatic environment of the areas downstream of the notches.

The Omaha District collected data on the physical conditions of over 150 notches during 1976, 1977, and 1979. Qualitative evaluations of debris retention, flow velocity, aquatic vegetation, and erosion were made during each inspection and velocity measurements were taken at selected notches. The data was analyzed by making comparisons between the three inspection years; the three design widths - 15 feet, 20 feet, and 30 feet; and the type of bank location. The results of this analysis indicated the notches located in the revetment structure have more difficulty in creating desirable habitat conditions than those in the dike structures. The 15-foot wide notches were found

to be more susceptible to debris than the large notches and also had the largest percentage of notches with no flow. The most significant change between inspection years was in the terrestrial vegetation behind the notch. The number of notches with no terrestrial vegetation downstream of the structures increased from 35 percent in 1976 to 66 percent in 1977, and 99 percent in 1979. With the objectives of the program being to increase the shallow water area and maintain flood flow conveyance of the river, a decrease in terrestrial vegetation downstream of the notches was expected. As the notch program continues to mature, it is likely that the amount of underwater vegetation will begin to increase as plants more suitable to shallow water begin to grow. Some flooded terrestrial vegetation and emergent cattails were reported by the NSAT study.

The Omaha District also scheduled a series of hydrographic surveys at 40 notches, with six notches surveyed during two different years. Three of the notches were in crossing control structures and the other three were in dikes. The surveys of the crossing control structure notches indicated above normal discharges promoted scour, and low discharges caused some aggradation. The surveys of the notches in dikes showed that only small changes occurred in the water surface area and depth, even though the river discharges were varied from 32,000 c.f.s. to 60,000 c.f.s. Data indicates that these notched dikes are maintaining the slack water habitats for which they were designed.

The Kansas City District analyzed data from detailed hydrographic surveys of the physical conditions at 40 notches as a representative sample for the lower 500 miles of the river. In most instances, the notches have been effective in creating desirable fish habitats. When a notch was placed in an L-head revetment where the landward area had already completely silted in, a scour hole 20 feet to 50 feet wide usually developed downstream of the notch. In some of the cases when higher discharges occurred, the entire area landward of the structure scoured out. Some maintenance problems with debris collection occurred in notches built to a width of 20 feet. Some problems with bank erosion were noted in notches constructed at the head of a chute or 100 feet wide. The notches 50 feet wide were found to limit debris, yet not endanger the bankline because of a high erosion rate. Notches in dike structures functioned similar to those in the Omaha District.

In addition to the notched structures, the Kansas City District also monitored some environmental areas created by rootless dikes. Some of these areas experienced high rates of erosion around the landward end and required additional bank protection.

In comparing the hydrographic surveys of the river, no adverse effects upon the navigation channel have been detected as a result of the notched structures.

The purpose of the study by the NSAT was to determine the types of habitat created by the notches and their value to and use by fish and wildlife. Fish sampling was done at 32 structures over a 2-year period by the University of Missouri, University of Kansas, Iowa State University, and the Nebraska Game and Parks Commission. Fifty-one species of fish were captured in 1977 and 55 species were taken during 1978. However, the number

of fish caught in 1978 was substantially lower, attributed largely to high river discharges. The results of the sampling indicated the most valuable notches were those which created relatively large areas of quiet water. Also, the chutes and enclosed pools were found to be very desirable.

Based upon the results of the data collected by the Omaha District, Kansas City District, and NSAT, it was evident that no single notch design criteria could be used for the range of conditions which exist on the river. It should also be emphasized that the most effective notching program is one that provides a continuous source of quiet water areas over the widest possible range of discharges.

When a notch program is being initiated, a priority system should be established which develops areas in order of their effectiveness to create and maintain a desirable slack water habitat.

The study results for the Missouri River indicate that the highest priority areas were to maintain the chutes and enclosed pools, typically found landward of L-head structures or crossing control structures. Whenever possible, these structures should be considered in pairs, with the upstream notch and backwater areas acting as a desilting basin for the downstream area. The second priority was found to be notches in dike structures (perpendicular to the flow). The third priority conditions were notches in the middle of a bend behind revetment structures (parallel to the flow). Even though the revetment notches have the lowest priority, they should eventually be developed to help achieve the goal of providing a continuous supply of backwater areas along the river, and maintain the flood carrying capability of the channel. Examples of notches in dikes, revetments, and L-head structures are shown in the photographs at the end of the report.

The width and depth dimensions of the notches are limited to a minimum size which will still allow enough flow to create a desirable habitat and avoid excessive debris accumulation. The dimensions are also limited to a maximum size which will not induce damaging erosion and endanger the integrity of the navigation project. For the study reach, notches should be built at a depth of 1 foot to 3 feet below the Construction Reference Plane (CRP) and a width of 20 feet to 50 feet. Some general guidelines for building notches are: (1) The width of a notch in a dike should be 10 percent to 25 percent of the riverward length of the structure, (2) the width and depth of the revetment notches should be 25 percent to 50 percent greater than the dike notches, (3) the depth of the notches should be increased with the probability of river stage fluctuations (depths of 1 foot to 2 feet were used for the upstream reach where the discharge is mainly controlled by the reservoir system releases and depths of 2 feet to 3 feet were used for the downstream portion where the tributaries have a greater impact which causes a greater amount of stage fluctuation). Even though these dimensions worked the best under the given river conditions, notches should be built to a variety of sizes in order to provide a diversity of quiet water areas under differing river flow conditions.